XXIII. *Farther observations on the feet of animals whose progressive motion can be carried on against gravity.* *By Sir* EVERARD HOME, *Bart. V. P. R. S.*

Read June 27, 1816.

SINCE my observations on the foot of the lacerta gecko and fly were laid before the Society, Mr. BAUER, of Kew, has made drawings of the feet of both these animals; in the hands of an artist who has attained such excellence in the correct representation of objects highly magnified, the mechanism by which the feet are fitted for supporting the weight of the animal against gravity, is much better shown.

Mr. BAUER has not confined his labours to these objects, but has applied the powers of the microscope to the examination of the feet of other insects, and has enabled me to show, that the principle on which progressive motion against gravity depends, is very extensively employed by nature in the structure of the feet of insects; indeed the means employed for this purpose are so various, as to form characters by which many genera may be distinguished.

I shall not enter farther into this enquiry than to show some of the varieties of the structure.

My friend, Dr. LEACH, whose researches in entymology fit him so admirably for the purpose, will, I trust, prosecute this subject, and ascertain the peculiarities that belong to the feet of different insects, fitting them for their peculiar habits

of life; which will assist him in giving a better arrangement of the subdivisions of this numerous class than has been hitherto done.

This structure of the feet of insects, now that it is known, can be very readily demonstrated by looking at the movements of the feet of any insect upon the inside of a glass tumbler, through a common magnifying glass; the different suckers are readily seen separately to be pulled off from the surface of the glass, and reapplied to another part.

The pockets on the under surface of the toes of the lacerta gecko, as they are represented in Plate XVII, show that what looked like a pectinated edge when seen through a common magnifying glass, consists of a complex structure, composed of rows of a beautiful fringe, which are applied to the surface on which the animal walks against gravity, while the pockets themselves are pulled up by the muscles attached to them, so as to form the cavities into suckers.

In the blue bottle fly, it will be seen, in Plate XVIII, that the suckers are two in number, that they are connected to the last joint of the toe, immediately under the root of the claw, and have a narrow infundibular neck attached to the toe, which has the power of motion in every direction; when these suckers are to be applied, they are separated from each other, and the membrane of each is expanded so as to increase the surface; but when disengaged, they become nearly closed, and are brought together, so as to be confined within the space between the two claws.

The external edge of each sucker is beautifully serrated, and the concave surface is granulated. When the fly is walking against gravity, and its motions are observed, they all appear

to be the result of muscular action, regulated by the will of the animal.

All the six toes are supplied with suckers.

In the horse fly, the tabanus of FABRICIUS, the suckers differ from those of the blue bottle fly in being three in number, in all other respects they are the same. In this fly, when the suckers are not used, the two outer ones close in before the other, and are only spread out when they are to be brought into use.

In the yellow Saw fly, the cimbex lutea of FABRICIUS, the suckers are differently situated from those of the fly; they are placed upon the under surface of the four first joints of the toes, one sucker upon each. These suckers are spoon shaped; they are represented in Plate XIX. The exterior part is thin and pellucid, but at half their depth they suddenly become thicker in their coats, forming a ridge at this part which gives the appearance of an inner cup, but this is a deception; the exterior membranous portion is alone expanded on the surface to which the sucker is applied, and the neck of the sucker forms the vacuum.

All the six feet have suckers.

The apparatus which has been described to support the animal in its progressive motion, is also applied to other purposes. In the great water beetle, the dytiscus marginalis, in which there is no appearance of suckers on the under side of the feet of the female, they are placed on the three first joints of the first and second pair of feet of the male, as is shown in Plate XX.; from which it is evident, that such suckers are used to retain the female in the embrace of the male. In the male, the three first joints of the feet of the

fore legs have the form of a shield, the under surface of which is covered with suckers, one very large, a second one-third smaller, and all the rest very small. In the second pair of feet, the corresponding joints are much narrower in proportion, and are covered on their under surface with very small suckers.

All these suckers, as is seen in Fig. 13, 14, and 15, have long tubular necks, which show more plainly than in the others the mode in which the vacuum is produced; it is exactly similar in its effect to that of a piece of leather with a string in the centre, applied in a moistened state to the surface of a stone.

Having explained this apparatus, so beautifully contrived to attach the feet to the surface on which the animal moves, I shall conclude this Paper by an account of a structure of a very different kind, for the purpose of taking off the jar when the body of the insect is suddenly brought from a state of motion to a state of rest; this is met with in the grylli and locustæ. Some of them have suckers at the ends of the toes, others have not.

In a species of gryllus with a corcelated thorax, brought from Abyssinia, by Mr. SALT, the feet are made up of three joints; on the under surface of the first are three pair of globular cushions, filled with an elastic fibrous substance, looser in its texture towards the circumference, which renders it still more elastic; under the second joint is one pair of similar cushions, and under the last joint, immediately between the claws, is a large oval sucker. A similar sucker is met with between the claws in a British grasshopper, the acrydium biguttulum (LATR.) These are common to all the six feet. They are represented in Plate XXI.

In the locusta varia, whose feet have four joints, under the first are two very small globular cushions, and two large oval ones; under the second, a corresponding pair of oval ones; and under the third, a pair of cushions different from the others, in being much larger, globular, and semi-transparent; there is no sucker between the claws, and this insect has no power of supporting itself against gravity.

As the flea has powers of jumping not exceeded by any other insect, it was natural to expect a similar apparatus under its feet; but as no such cushions are met with, we must conclude that the lightness of its body rendered them unnecessary.

## EXPLANATION OF THE PLATES.

### PLATE XVII.

Represents six different views of the third toe of the fore foot of the lacerta gecko.

Fig. 1. Is the upper surface of the toe, to show the manner in which it spreads laterally.

Fig. 2. The under surface of the same toe, to show the orifices of the pockets or suckers. These two figures are magnified 100 times.

Fig. 3. Two portions of two contiguous suckers, showing that the fringed termination is only continued from the ends of the alternate membranous partitions. The parts are magnified 2500 times.

Fig. 4. A front view of a longitudinal section, to show the bones and muscles.

Fig. 5. A side view of a longitudinal section. These two are magnified 100 times.

Fig. 6. A side view of a portion of some of the suckers, showing the insertion of the muscles, magnified 2500 times.

## PLATE XVIII.

Fig. 1. A left front leg of the blue bottle fly, musca vomitoria, magnified 100 times.

Fig. 2. A view of the under side of the last joint of the toe, with the two suckers expanded, as seen when the fly is walking against gravity.

Fig. 3. Side view of ditto.

Fig. 4. Upper side of ditto. These three figures are magnified 6400 times.

Fig. 5. View of the under side of a single sucker of a dead fly.

Fig. 6. Side view of ditto.

Fig. 7. Upper side of ditto. These three figures are magnified 6400 times.

Fig. 8. Left front leg of bibio febrilis (LATR.) Magnified 100 times.

Fig. 9. The under side of the last joint of the toe of ditto.

Fig. 10. Side view of ditto.

Fig. 11. Upper side of ditto. These three figures are magnified 6400 times.

## PLATE XIX.

Fig. 1. The left front leg of cimbex lutea, (FABR.) *a*, thigh; *b*, shank; *c*, calces; *d*, toe; *e*, plantar suckers; *f*, sucker between the claws; *g*, unguis or claw.

Fig. 2. Side view of ditto.

Fig. 3. Under side of the left front leg. These three magnified 100 times.

Fig. 4. Last joint of toe, upper side, magnified 400 times.

Fig. 5. Under side of toe, and extremity of the shank, magnified 400 times.

Fig. 6 and 7. Upper and side views of two joints of the toe, magnified 400 times, to show the plantar suckers.

Fig. 8 and 9. Calces, magnified 1600 times, to show the form of the sucker with which each is terminated.

## PLATE XX.

Fig. 1. The left front leg of the male dytiscus marginalis.

Fig. 2. Ditto, under side. They are both magnified 25 times.

Fig. 3. Tarsus of ditto.

Fig. 4. Side view of ditto.

Fig. 5. Under side of ditto. These three are magnified 100 times.

Fig. 6. Front view of the sucker (*a*) fig. 5, magnified 100 times.

Fig. 7. Side view of the sucker (*b*) fig. 5, magnified 100 times.

Fig. 8. Front view of the suckers (*c*) fig. 5, magnified 400 times.

Fig. 9. Several of the suckers (*c*) fig. 5, magnified 400 times.

Fig. 10. Second or middle left leg of dytiscus marginalis, magnified 25 times.

Fig. 11. Tarsus of ditto, under side, magnified 100 times.

Fig. 12. Several of the suckers (*a*) fig. 11, magnified 900 times.

Fig. 13, 14, and 15. Suckers (*a*) fig. 11. magnified 40,000 times, to show the articulation between the peduncle and the

sucker, and the joint by which the peduncle is attached to the tarsus.

Fig. 16. The hinder left leg of dytiscus marginalis, male, magnified 25 times.

Fig. 17. The left front leg of dytiscus marginalis, female, magnified 25 times.

## PLATE. XXI.

Fig. 1. The left front leg of a species of the genus gryllus, (FABR.) with a corcelated thorax, from Abyssinia, magnified 9 times.

Fig. 2. A toe of ditto, to show the under side, on which are cushions attached to the first and second joints; *a*, the oval sucker between the claws; *bbbb*, the cushions.

Fig. 3. Ditto, side view.

Fig. 4. Ditto, upper side.

Fig. 5. Vertical section of the organs, fig. 2. *b*.

Fig. 6. Longitudinal section of ditto. All these are magnified 100 times.

Fig. 7. A front view of the left fore foot of a British species of grasshopper, acrydium biguttulum, (LATR.) to show that it has the same oval sucker between the claws, and the cushions, as in the grasshopper from Abyssinia. The parts were drawn from the animal while alive. The Abyssinian grasshopper had been preserved in spirit.

Fig. 8. A side view.

Fig. 9. A back view. These three views are magnified 2500 times.

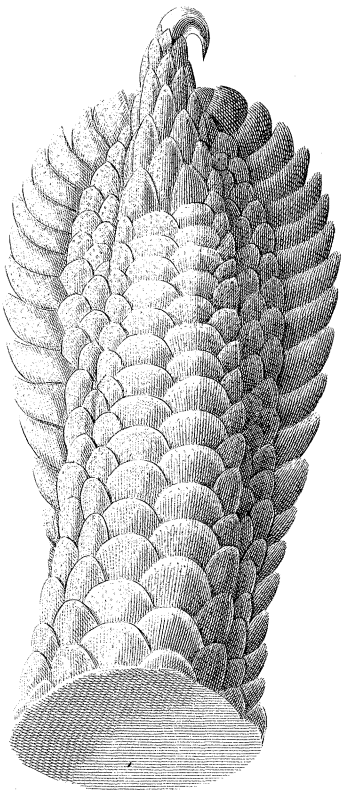
Fig. 10. A left front leg of a British species of grasshopper, locusta varia, (FABR.) magnified 36 times.

Fig. 11. View of the underside of the toe.

Fig. 12. Side view of ditto.

Fig. 13. Upper side of the toe. These are magnified 625 times.

The cushions under the joints of the toe in this grasshopper, resemble in structure those of the Abyssinian gryllus, but differ in their form and situation. There is no sucker between the claws.



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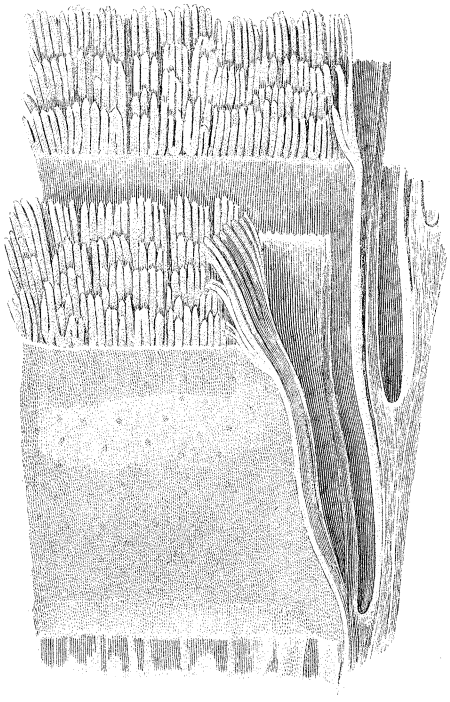

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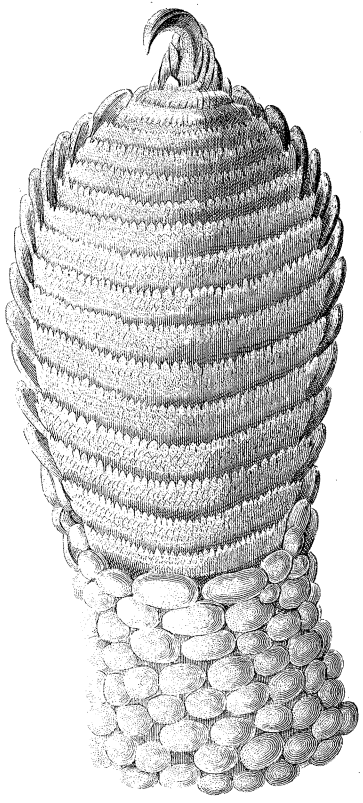

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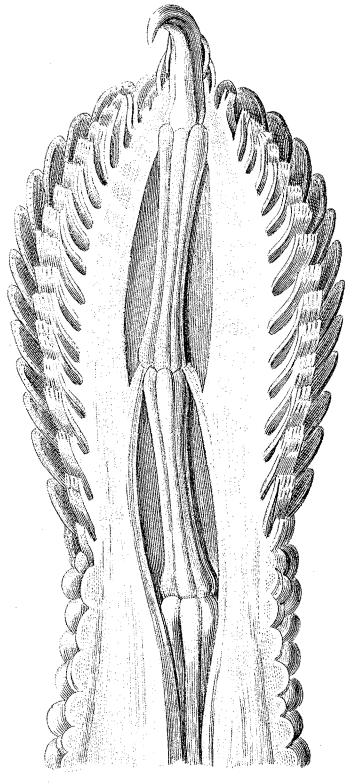

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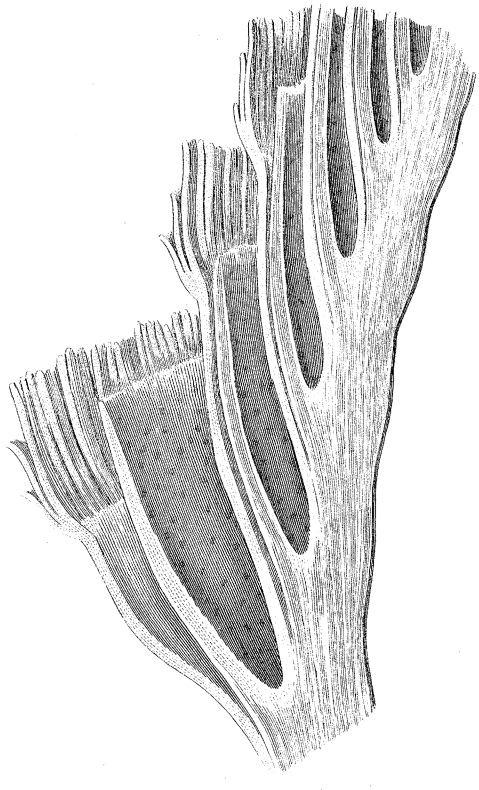

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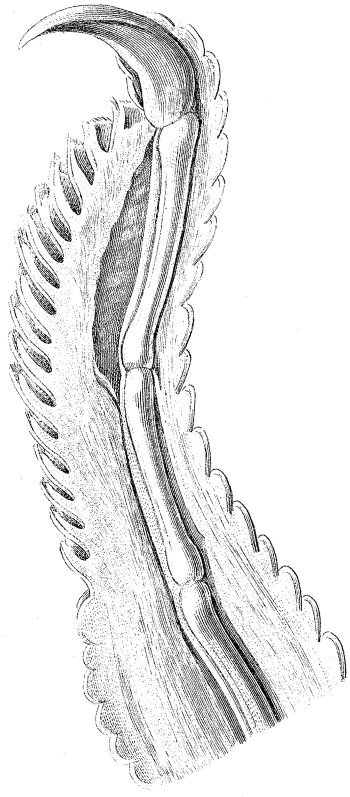

Fig. 5.

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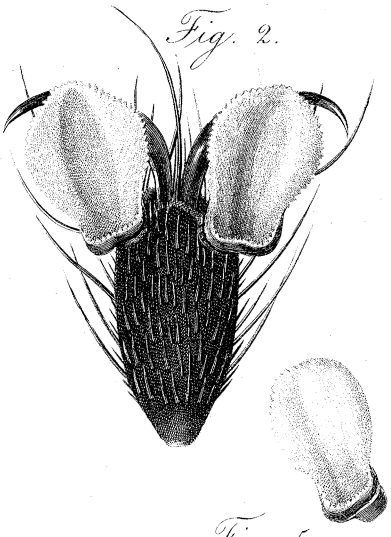

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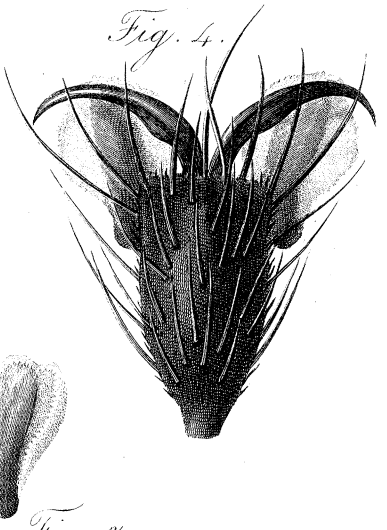







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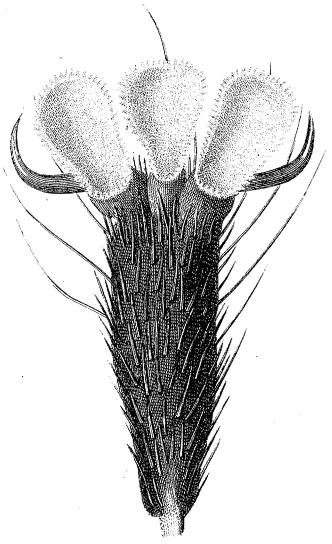

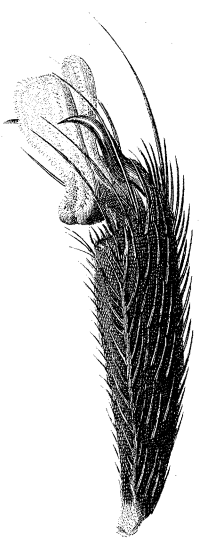

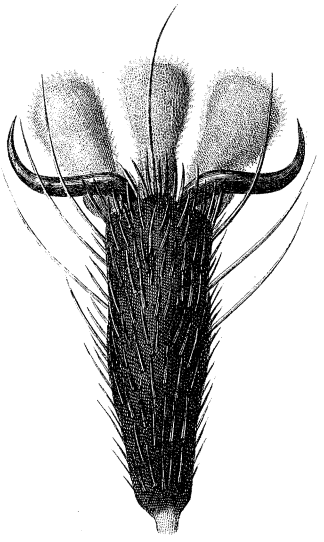

*Fig. 9* *Fig. 10.* *Fig. 11.*

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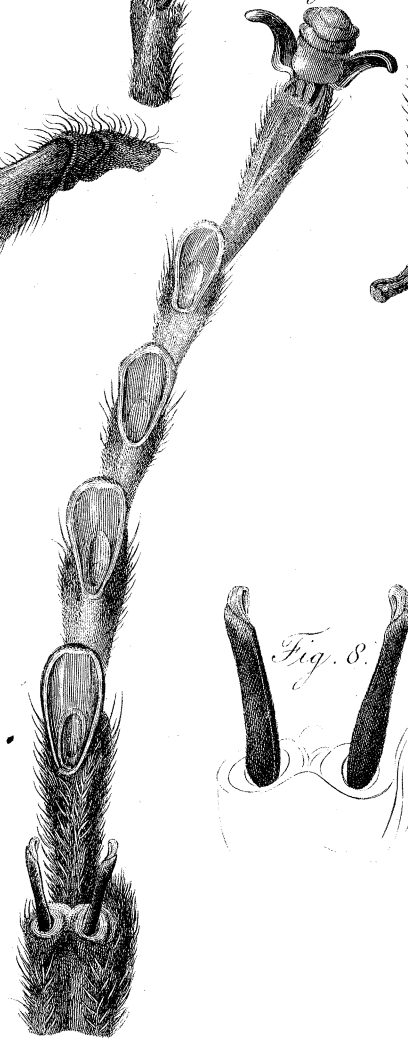

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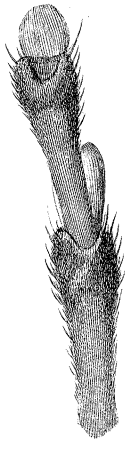

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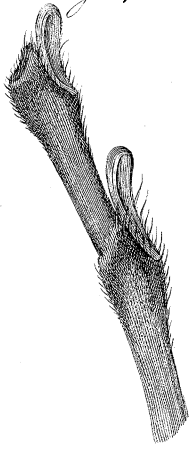

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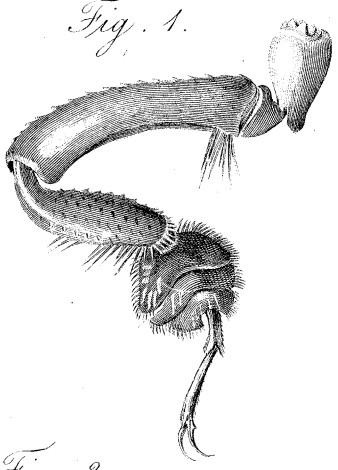

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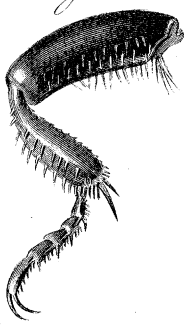

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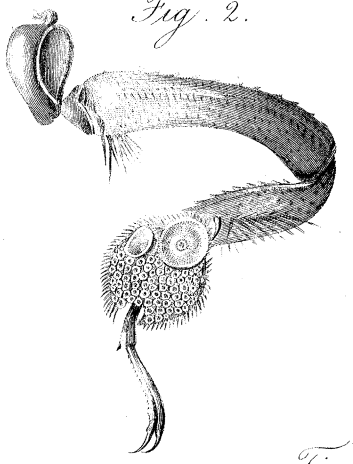

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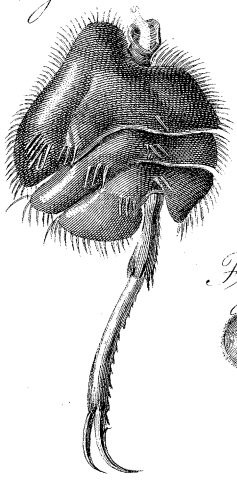

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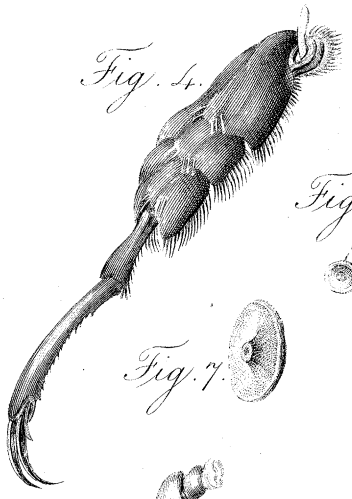

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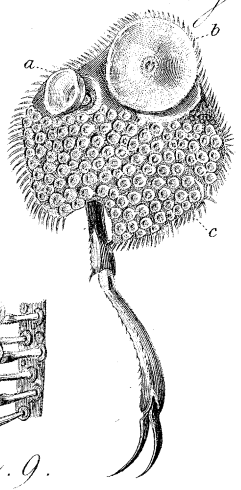


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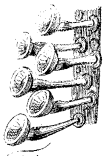

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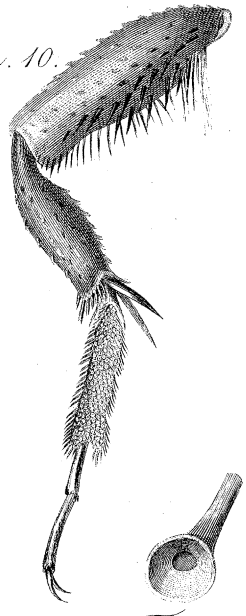

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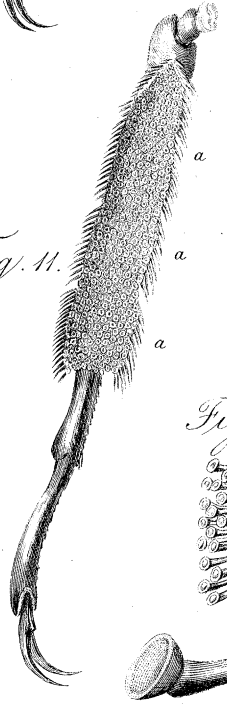


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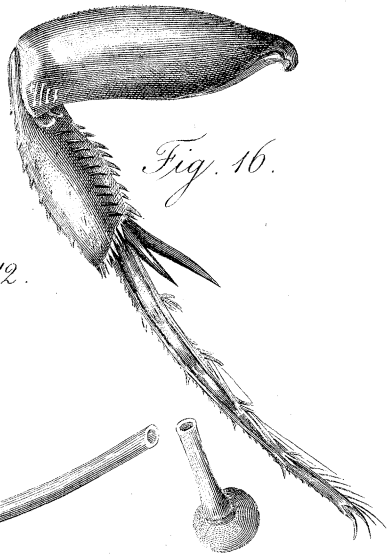

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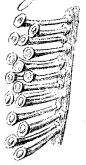

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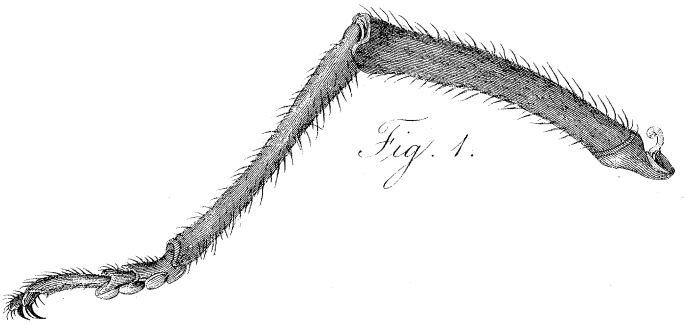

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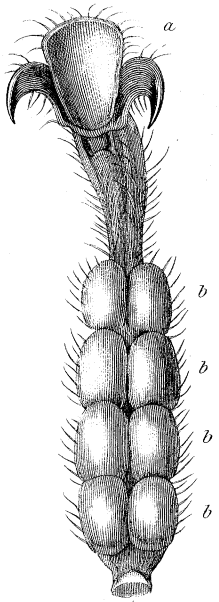


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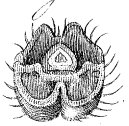

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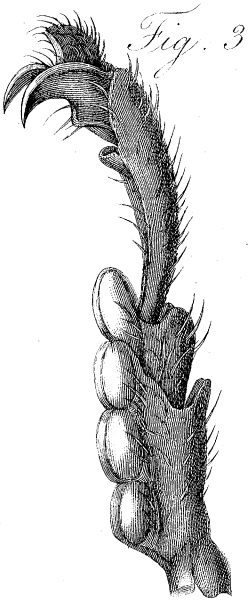

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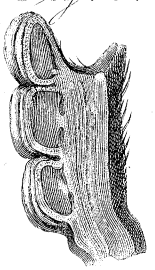

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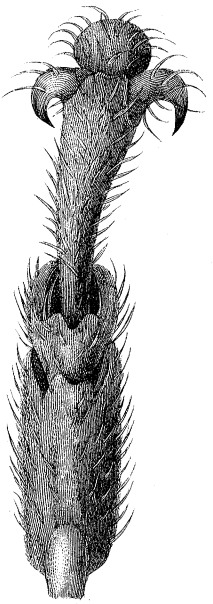

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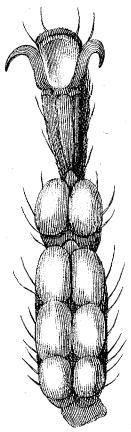

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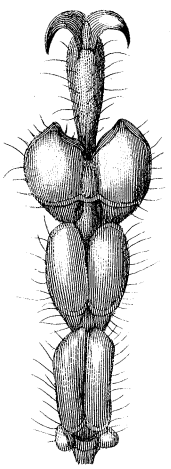

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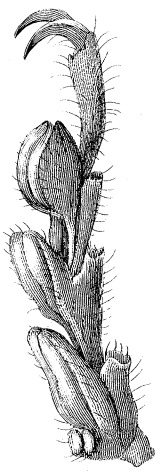

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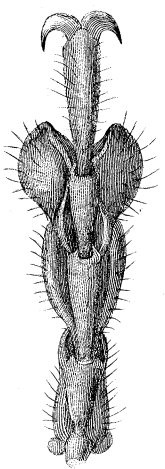

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